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# NASA TECH BRIEF

*NASA Pasadena Office*

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## Multi-Dimensional Real Fourier Transform

### The problem:

To compute the one-dimensional and multi-dimensional Fourier transforms for real data, the multi-dimensional complex Fourier transforms, and the multi-dimensional sine, cosine, and sine-cosine transforms.

### The solution:

Four subroutines, each of which performs the required calculation for one of the four problems given. Each subroutine uses the Cooley-Tukey Fast Fourier Transform (FFT), and, in all but the one-dimensional case, the transforms are calculated in up to six dimensions.

### How it's done:

The Cooley-Tukey algorithm is an efficient computational procedure for evaluating expressions of the form:

$$X_j = \sum_{k=0}^{N-1} a_k W^{jk}, \quad \begin{matrix} j = 0, 1 \dots N-1 \\ W = e^{2\pi i/N} \\ i^2 = -1 \end{matrix}$$

where  $x_j$  and  $a_k$  are complex, and  $N$  is composite. If the calculations were to be carried out in a straightforward manner, with an operation defined as one complex multiplication and addition, a total of  $N(N-1)$  operations would be required; i.e.,  $N-1$  operations for each value of  $j$ . The Cooley-Tukey algorithm, however, organizes the calculations in such a way that only  $(N \log_2 N)$  operations are required, which represents a significant savings for large  $N$ .

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### Notes:

1. These programs are written in FORTRAN V for use on the UNIVAC-1108 computer.
2. The specific subroutines are as follows: NPO-11648, Multi-Dimensional Real Fourier Transform; NPO-11649, One-Dimensional Real Fourier Transform; NPO-11651, Multi-Dimensional Complex Fourier Transform; and NPO-11652, Multi-Dimensional Sine, Cosine, and Sine-Cosine Transforms.
3. Inquiries concerning these programs should specify the program desired, and may be directed to:

COSMIC  
Barrow Hall  
University of Georgia  
Athens, Georgia 30601  
Reference: B71-10133

### Patent status:

No patent action is contemplated by NASA.

Source: Fred T. Krogh of  
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